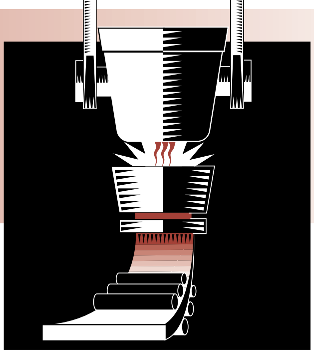
# STEEL

Project Fact Sheet



## Development of Submerged Entry Nozzles that Resist Clogging

### Benefits

- Reduced refractory costs
- Increased steel quality/cleanliness
- Increased steel production through elimination of unscheduled shutdowns and consistent throughput
- Increased energy efficiency

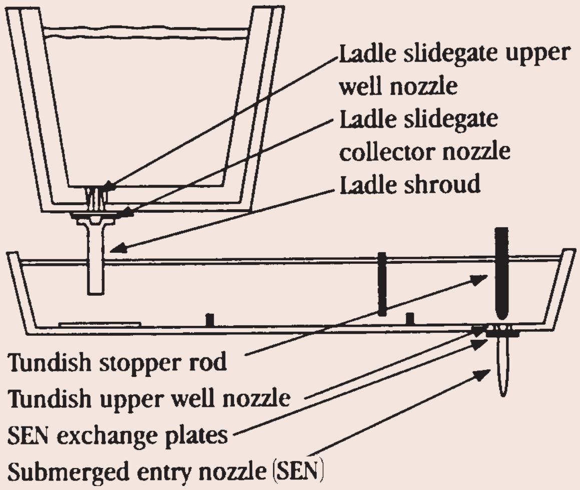
### Applications

Submerged Entry Nozzles (SENs) are used in the steelmaking process to prevent reoxidation of the molten steel directly from stream contact with the surrounding environment and from air entrainment and splashing when the molten stream strikes the liquid surface in the mold. Elimination of accretion formation and the associated clogging of SENs will lead to increased strand speed, greater time between changes of SENs, and reduced strand termination incidence.

**Development of submerged entry nozzles (SENs) can increase yields, improve product quality, and increase productivity in continuous casting of steel, a process used for the production of 95% of steel in the U.S.**

This project is a comprehensive refractory research program that will provide the data necessary to define the mechanisms controlling nozzle accretion, providing the basis for developing new technologies for reduction or elimination of nozzle clogging. The project consists of four major activities: 1) A detailed post-mortem microstructural characterization of multiple nozzle accretions from steelmaking facilities using a range of casting conditions; 2) Development of a high temperature simulation that accurately reproduces the accretion so that materials can be evaluated under controlled conditions using a design of experiments approach; 3) Documenting a detailed wetting behavior of nozzle materials by molten steel as a function of steel chemistry and temperature; and 4) Development of a simulation that accurately reproduces the thermal shock conditions that are present during use of nozzles.

**Submerged Entry Nozzle**




**Typical submerged nozzle configuration.**

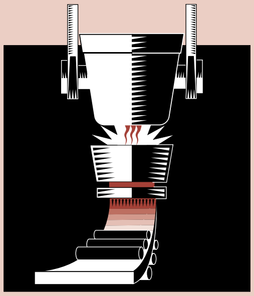
## Project Description

**Goal:** Identify combinations of steelmaking practices, flow combinations, and refractory materials that resist clogging.

Successful development of a nozzle that results in improved clogging resistance will result in reduced steel production costs, increased steel quality, increased steel production through more consistent operation, and increased energy efficiency.

## Progress and Milestones

- Project start date, July 1998. Duration, three years.
- Participant surveys, literature reviews, post-mortem characterization are completed.
- Accretion simulation and verification are complete.
- Wetting characteristics of iron and steel on selected substrates is in progress and will continue through the end of the program.
- Metallurgical effects on the accretion simulation are in progress and will be completed in February 2001.
- Steel/refractory interaction studies are in progress and will be completed in May 2001.
- Accretion of candidate nozzles will be completed in July 2001.
- Thermal stock validation of promising nozzle compositions will be completed in July 2001.
- Field trials will be initiated late in 2001 if warranted.



### Project Partners

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American Iron and Steel Institute
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AK Steel Corporation
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